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Howard K. Gloyd, Director.

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Bulletin
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Chicago Academy of Sciences

A Review of the Family Tenuialidae with a Description of a New Species from Colorado and Utah[1] (Acarina: Oribatei)

Tyler A. Woolley[2] and Harold G. Higgins[3]

In 1913 Ewing established *Tenuiala* as a new genus in the family Oribatidae and characterized it by "long, narrow, anteriorly directed, macro-cusp-like pteromorphs . . . . immovably attached to the abdomen." He found no variations in the four specimens he collected in Oregon.

Jacot (1929) described a new subfamily, Tenuialinae, which he distinguished by "pteromorphae extending along the sides as rigid plates, free from each other." He incorporated the genera *Tenuiala* Ewing, 1913, and *Hafenrefferia* Oudemans, 1906, in the subfamily. The latter was a redescription and redesignation of *Oribates gilvipes* C. L. Koch, 1839.

Both Sellnick (1929) and Willmann (1931) recognized *Hafenrefferia* as a genus in the family Liacaridae. Baker and Wharton (1952), however, elevated Jacot's subfamily name to family rank and placed both *Tenuiala* and *Hafenrefferia* within this category. In the same year Sellnick (1952) described *Hafenrefferiella,* a new genus from Portugal similar to *Hafenrefferia,* which he also placed in the family Liacaridae.

While all three genera possess characteristics which indicate a relationship to the Liacaridae, the authors are of the opinion that the simi-

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larities of body form, pteromorphae, lamellae and genital setae are sufficiently constant and distinct to justify the inclusion of these genera in a separate family. The taxonomic delineations of the family follow on this basis.

Family TENUIALIDAE Jacot, 1929

Type: *Tenuiala nuda* Ewing, 1913, p. 133.

Diagnosis: Triangular, rigid pteromorphae which project anteriorly from the hysterosoma ; lamellae distinct with an anterior cusp projecting beyond point of attachment or beyond translamella ; with six setae on each genital cover, the first (anterior) pair inserted in anterior margin of covers, the second pair inserted close to anterior margin of each cover. Insertions of the legs and other aspects of body form indicate relationship with the Liacaridae, but the pteromorphae distinctly separate the Tenuialidae from the Liacaridae.

Description: Chelicerae chelate ; propodosoma with a pointed rostrum which may be notched, covering mouth parts from above ; rostral, lamellar and interlamellar hairs present, sparsely ciliate ; lamellae distinct, with anteriorly projecting cusp ; some species with translamellae ; pseudostigmata sometimes coalesced with proximal part of lamellae, cup-shaped ; pseudostigmatic organs narrowly clavate at distal tips, ciliate or with minute spines ; pteromorphae distinct, rigid, triangular projections of the hysterosoma, with or without serrated medial edges ; tectopedia I triangular, projecting anteriorly between gnathosoma and pteromorphae or closely applied to gnathosoma; genital covers with six pairs of setae, first pair inserted in anterior margin of cover, second pair inserted close to anterior margin of each cover.

Genus *Tenuiala* Ewing, 1913

Type: *Tenuiala nuda* Ewing, 1913, p. 134, Figure 5, rotting log, top of Mt. Chintimini, Oregon.

Diagnosis: Pteromorphae long, forward-projecting triangles, serrated on medial margins ; lamellae long and broad, cusp a short, broad projection extending beyond anterior edge of gnathosoma.

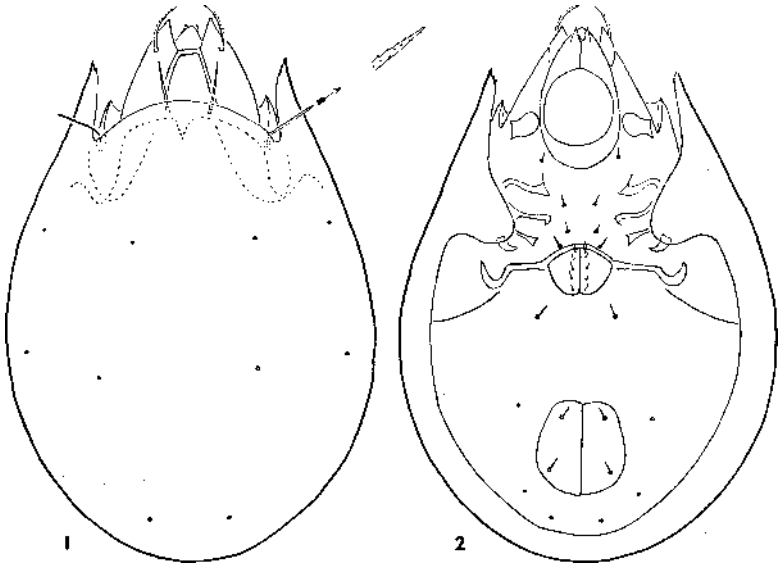
Tenuiala nuda Ewing, 1913

Figures 1, 2

Diagnosis: Lamellae broad, unnotched on lateral margins, separated throughout their lengths except for a narrow translamella at base of cusp ; cusps projecting beyond anterior edge of gnathosoma.

Description: Propodosoma about one-sixth as long as hysterosoma, distinctly separated from the latter and covering mouth parts from above. Lamellae large, of nearly equal width throughout their lengths, nar-

rowing slightly anteriorly and extending beyond anterior tip of gnathosoma, unnotched and pointed. Lamellar hairs approximately as long as width of lamella, ciliated and curved, inserted about half the length of the hair from anterior tip of lamella. A translamella present, about as long as width of lamella at level of lamellar hairs. (Ewing's original description does not indicate the translamella, nor does his drawing.) Interlamellar hairs present, about as long as the width of lamellae at their bases, inserted close to medial edges of lamellae. Pseudostigmatic organs long, lance-shaped and slightly recurved, with minute barbs along the shaft, pseudostigmata appear as recessed pockets from which the pseudostigmatic organs emerge (Fig. 1) .



Tenuiala nuda Ewing, legs omitted: Figure 1, dorsal view ; Figure 2, ventral view.

Hysterosoma globular, polished, dark brown, with five pairs of setal insertions, but without visible setae. Pteromorphae rigid, extending forward midway to anterior end of propodosoma, with serrated inner margins near tip. (Ewing indicates in both drawings and description that the pteromorphae are notched at their tips, a detail which perhaps was overemphasized in his illustration and description of these serrations.)

Camerostome oval, palpi five-jointed, mandibles chelate. Tectopedia I stout, triangular, posterior to tip of pteromorphae, between ptero-

morphae and propodosoma. Genital plates at anterior margin of ventral plate, as broad as long and situated about twice the length of a single plate from the anal aperture, somewhat triangular in outline, with six pairs of genital setae ; first two pairs of setae close to anterior margin of genital covers. Apodeme of Leg IV laterad of level of first two pairs of genital setae. Anal plates about twice as long as genital plates, rectangular and twice as long as broad, with two pairs of setae, a:1 about its length from anterior margin of anal plate and medial margin ; a:2 about half its length from postero-lateral margin of anal cover. Other ventral setae as indicated in Figure 2. Legs of moderate size, posterior pair not extending beyond the posterior margin of hysterosoma.

Length of body 771μ, hysterosoma 670μ, width 542μ.

Discussion: This redescription of a cotype of *Tenuiala nuda* Ewing follows the general arrangement of Dr. Ewing's original publication (1913) with modifications by the writers. The original pencil drawings of the cotype were made by Dr. E. W. Baker and sent to the senior author.

Nine specimens of this species were taken by Harold G. Higgins, 5 miles west of Green Lakes, Uintah Mountains, Utah, under logs of *Pinus ponderosa,* July 19, 1953.

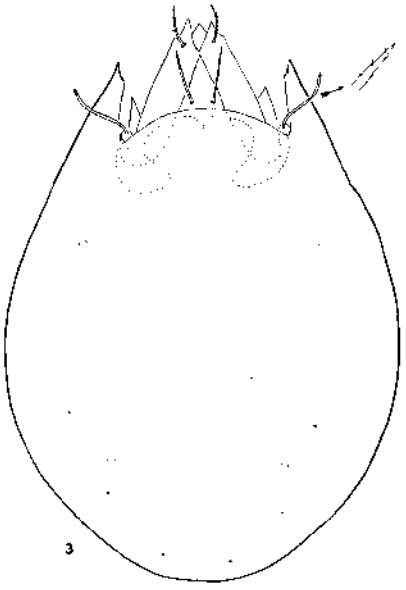
Tenuiala kurti sp. nov.

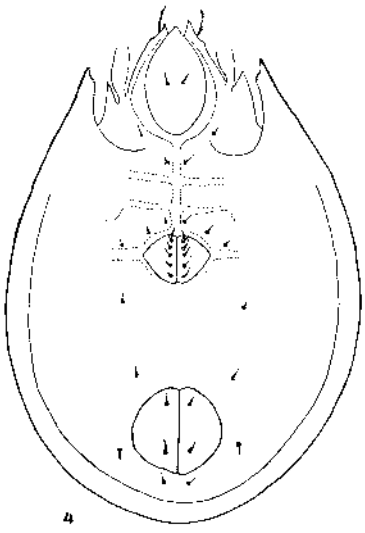
Figures 3, 4, 5, 6, 7

Diagnosis: Lamellae wide and long, joined antero-medially without a translamella, antero-lateral margins of lamellae notched ; pteromorphae pointed and stiff, medial edges serrated anteriorly ; hysterosoma dark brown to black, without visible setae, but with setal insertions; tarsus I with a dorsal setal complex of three straight and one bent setae (Fig. 5). Differing from *T. nuda* Ewing in the notched lamellae, the absence of a translamella and minor differences of the pteromorphae and pseudostigmatic organs.

Description: Propodosoma and hysterosoma distinctly separated. Propodosoma small, covering mouth parts ; mandibles chelate ; palps with five segments. Lamellae wide and long, joined anteriorly at their medial tips without a translamella, margins nearly parallel throughout lengths ; cusps pointed anteriorly, projecting anterior to rostrum, with a pronounced lateral notch. Lamellar hairs about as long as width of lamella, slightly curved, ciliate, projecting beyond lateral edge of lamellae about half their length and generally bisecting the lamellar notch. Interlamellar hairs about a third longer than lamellar hairs, stouter and less ciliate, projecting nearly to insertions of lamellar hairs.

Pseudostigmata cone-like, beneath anterior margin of hysterosoma at medial edge of base of pteromorphae, projecting end smooth, rounded. Pseudostigmatic organs long, tapered, clavate and directed anterolaterad, sparsely ciliate or barbed toward tip (Fig. 3).





Tenuiala kurti sp. nov., legs omitted: Figure 3, dorsal view; Figure 4-, ventral view.

Hysterosoma round-oval, highly arched, dorsal setae not present, but setal bases as indicated in Figure 3. Pteromorphae pointed and stiff, directed slightly ventrad, medial edges serrated anteriorly, the number of teeth varies with specimens as indicated in Figure 6 ; some with longitudinal reticulations on dorsal surface of pteromorphae, which are broadly joined to hysterosoma.

Camerostome oval in outline ; palpi five-jointed, mandibles chelate. Tectopedia I prominent, anterior point reaching level of the middle of the length of lamella, serrate at tip. Genital covers about as long as wide, trapezoidal in outline, between legs IV, apodemes of legs IV bisecting lateral margins; covers about half as large as anal plates and separated from anal covers by more than twice length of genital covers; genital covers with six pairs of setae (Fig. 4), the anterior two

pairs close to anterior margin of genital cover, g:1 inserted in slight notches in anterior margin of genital cover ; g:2 insertion nearly touching base of anterior bristle (g:1) , remainder of genital setae as in Figure 4. Anal plates longer than broad, each with two widely separated setae, a:1 near anterior margin, a:2 about half the width of anal plate from posterior margin.

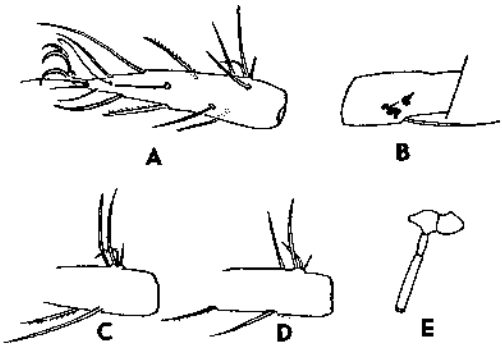


Figure 5. Tarsus I and a fungal spore from *Tenuiala kurti* sp. nov.: A, dorsal setal complex, lateral view ; B, dorsal setal complex, dorsal view ; C, D, variations of dorsal setal complex; E, fungal spore and mycelium as seen through integument of hysterosoma.

Legs moderately long. Tarsus I tridactyle, with mostly simple setae, usually with one dorsal and one ventral ciliate seta ; with a dorsal complex of four setae, one of which is usually bent (Fig. 5) ; coxa and trochanter IV flattened and with distinct keel.

Length 1020μ, width 680μ. Twenty specimens from Utah and Colorado have the following minimum, average and maximum body measurements : length, 900, 1010, 1140μ, ; width, 650, 710, 750μ.

Discussion: Limited collections in Utah, Idaho and Colorado indicate that these mites are widespread and abundant in rotting logs and decaying wood at least during the months of July, August and September. They are usually found in areas of conifers and aspen above elevations of 8,000 feet. They evidently feed on fungus as indicated by the fungal spores and mycelia observed within the bodies of several specimens.

The holotype and nine paratypes were taken from rotting spruce logs near Lost Lake, Wasatch National Forest, Wasatch County, Utah, August 2, 1954, by Harold G. Higgins.

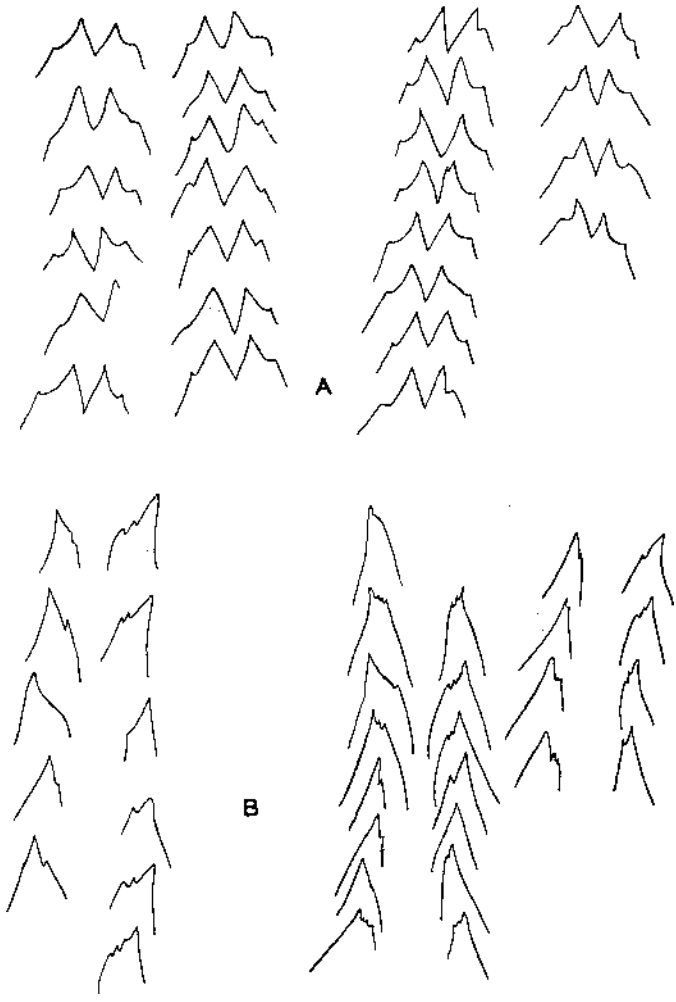


Figure 6. Variations in (A) lamellar and (B) pteromorphal outlines of specimens of *T enuiala kurti* sp. nov., from Utah (left) and Colorado (right).

Specimens of this species were also collected by Higgins from rotting spruce logs near Cottonwood Reservoir No. 1, Grand Mesa, Mesa County, Colorado, July 10, 1952, and by Woolley from Middle St. Vrain Camp Ground, Boulder County, Colorado, August 28, 1954.

The holotype and two paratypes were deposited in the U. S. National Museum. Additional paratypes were deposited in the Canadian National Museum, Ottawa, Canada, and the British Museum (Natural History), London, England.

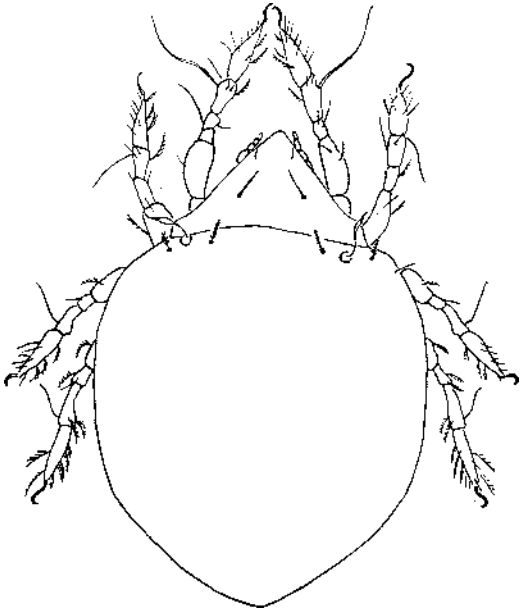


Figure 7. Nymph of ***Tenuiala kurti*** sp. nov., dorsal view.

Genus *Hafenreferia* Oudemans, 1906, p. 61

Type: *Oribates gilvipes* C. L. Koch, 1839.

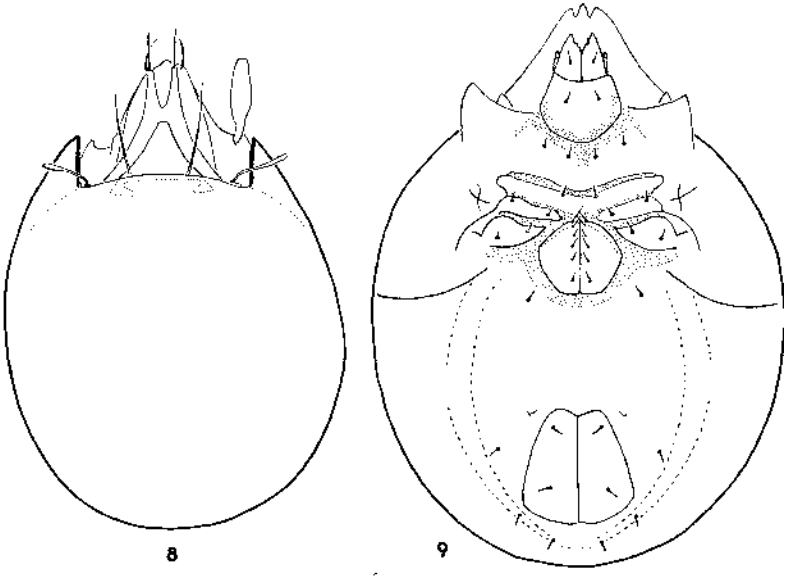
Diagnosis : Pteromorphae short, stout triangles with heavily sclerotized medial margins ; lamellae long, narrow, with nearly parallel sides, joined at base of cusps by a short translamella ; cusps long, notched at distal tips for insertion of lamellar hairs. Tectopedia I a narrow, tapered blade.

Hafenrefferia gilvipes (C. L. Koch, 1839) Oudemans, 1906

Figures 8, 9, 12

Type: *Oribates gilvipes* C. L. Koch, 1839, p. 14.
Liacarus pterotus Coggi, 1900, p. 322.
Liacarus auritus Nordenskiold, 1901, p. 20.

Diagnosis: Lamellae narrow, with a translamella ; cusps notched at distal tips for insertion of lamellar hairs; pteromorphae short, triangular blades with heavily sclerotized medial margins. Differs from *Tenuiala* in shorter pteromorphae, narrow lamellae, the distinct translamella and the notched insertions of the lamellar hairs.



Hafenrefferia gilvipes (C. L. Koch, 1839) Oudemans 1906, legs omitted: Figure 8, dorsal view; Figure 9, ventral view (after Sellnick, 1952).

Dr. Sellnick (1952) compares features of *Hafenrefferia gilvipes* (C. L. Koch) and *Hafenrefferiella nevesi* Sellnick in a running account. The writers have consolidated these comparative descriptions for each species and have placed them below with slight modifications as required to maintain a uniform sequence.

Description: Propodosoma pointed, rostrum deeply notched, the lateral projections sharply pointed, the central projection a pointed tongue. Rostral hairs inserted about a fourth their length behind the

rostral notches, curved and sparsely ciliate. Lamellae long and narrow, with nearly parallel sides, joined at base of cusps by a short translamella, cusps half as long as attached part of lamellae, each with almost parallel sides, the interval between as wide as one cusp ; cusps notched at anterior end, notch with two small points, the inner one usually longer than the outer one. Lamellar hair inserted in this notch ; hair as long as cusp and half as long as attached part of lamella. Interlamellar hairs erect, inserted two thirds their length from each other.

Pseudostigmata cup-like, coalesced with the proximal end of lamella, directed outward and upward. Pseudostigmatic organ recurved backward and outward, almost cylindrical, the distal half slightly thickened, somewhat clavate, but pointed at distal end, the distal half of the hair finely toothed or barbed.

Pteromorphae short, stout, rigid triangles attached to hysterosoma, distal ends free, entire medial margins strongly sclerotized.

Tectopedia I a narrow blade tapering gradually towards the distal end, reduced to a mere line at anterior border of rostrum in a level with the deepest point of rostral notches, converging markedly. Tectopedia II a large, spoon-like blade at lateral edge of propodosoma.

Propodosoma and hysterosoma distinctly separated dorsally by a convex line. Hysterosoma high, egg-shaped, pointed in front, rounded behind, dark brown in color. Dorsal surface smooth, shiny, without hairs, but showing setal insertions and openings which might be fissures of glands.

Camerostome oval, bristles as indicated in Figure 9. Third apodema united with anterior border of genital opening, both apodemata forming a single transverse chitinous beam. Apodema IV a strong bar surrounding the lateral angle of genital plate.

Genital plates slightly longer than wide, trapezoidal in outline, between sclerotized arms of apodema IV, with six genital setae in a row along medial margin of each cover, anterior seta longest and on anterior border of cover ; anterior border of genital cover overlaps ventral plate slightly, but cover tends to be directed inward.

Anal aperture tapers forward, with two setae on covers as indicated in Figure 9. There are two glandular fissures in the ventral plate near the antero-lateral margins of anal plates. Ventral plate with two low and narrow impressions which begin behind the anterior outer edge of the genital opening and run in a flat bow to posterior outer edge of anal opening, uniting behind it. Ventral setae are indicated in Figure 9. The tarsi of the legs have three claws of equal length and thickness.

Length 972μ, width 625μ.

Discussion: According to Sellnick (1952) this monotypic genus has been collected in Germany, Sweden, Italy and Finland. As indicated in the synonomy, Koch's original species, *Oribates gilvipes,* was described under two different names by Coggi (1900) and Nordenskiold (1901).

The writers have not seen specimens of this species.

Genus *Hafenrefferiella* Sellnick, 1952

Type: *Hafenrefferiella nevesi* Sellnick, 1952.

Diagnosis: Pteromorphae short, stout triangles, slightly sclerotized along proximal half of medial margins, with longitudinal ripples. Lamellae remote from each other, with somewhat parallel sides, with sharply pointed cusps ; cusps nearly a third as long as length of lamellae. Lamellar hair in middle of upper edge of cusp. Tectopedia I a fairly broad blade, the distal end broader than proximal, concave at distal end, the upper border ending in a sharp point.

Hafenrefferiella nevesi Sellnick, 1952

Figures 10, 11, 12

Type: *Hafenrefferiella nevesi* Sellnick, 1952

Diagnosis: Lamellae narrow, without a translamella ; cusps pointed at distal tips ; lamellar hairs inserted in middle of upper edge of cusp ; pteromorphae short, triangular blades with slight ripples in surfaces, proximal half of medial edge slightly more sclerotized than distal half.

Description: Propodosoma with a pointed rostrum, which under high magnification shows two low indentations and three blunt projections of equal length, the lateral projections broader than the central one. Rostral hairs inserted approximately half-way between anterior border of rostrum and tip of cusp, insertions separated about the distance of narrowest space between lamellae, and on a level with the anterior end of tectopedia I ; rostral hairs about as long as lamellar hairs, directed forward, curved inward slightly. Lamellae of moderate width, their proximal parts somewhat broader than their distal ends, remote from each other by twice the width of lamella ; cusps prolonged anteriorly from attached part of lamellae, projected slightly at medial and proximal ends. Translamella absent. Lamellar hairs inserted in small notches in middle of outer border of cusps, each hair half as long as attached part of lamella. Interlamellar hairs erect, inserted near medial edge of lamellae in a triangle formed by anterior border of hysterosoma and lamellae (notogastral plate) where plate overlaps posterior border of propodosoma ; hairs separated their own lengths

from each other, nearly as long, perhaps a little longer than lamellar and rostral hairs, finely barbed like other hairs.

Pseudostigmata (bothridae) cup-like and coalesced with proximal part of lamellae, directed somewhat outward and upward. Pseudostigmatic organs recurved backward and outward, almost cylindrical, the distal half slightly thickened and somewhat clavate, slightly pointed at distal end, the distal half finely toothed or barbed.

Tectopedia I a blade on edge, gradually widened toward distal tip, distal end excavated so that upper border ends in a pointed corner and is not longer than attached lower border of blade ; upper corner of tectopedia I as remote from insertion of rostral bristles as both hairs are from each other.

Body rather high, egg-shaped, pointed in front, rounded behind, surface smooth and shiny, dark brown. Hysterosoma overlaps propodosoma and exhibits a number of obliquely placed, parallel ridges (Fig. 10). Dorsal surface of hysterosoma without visible setae, but with setal insertions and fissures of glands. Two hairs project from posterior margin of body (Fig. 10, 11) but are inserted in ventral plate behind anal aperture.

Pteromorphae triangular (Fig. 10), outer side of triangle longest, the two inner sides shorter, of equal length ; medial edge sclerotized slightly along proximal half.

Camerostome oval, mandible larger than *Hafenrefferia gilvipes,* but similar in structure, basal part of digitus bulbous, distal half with three teeth, setae as in Figure 11.

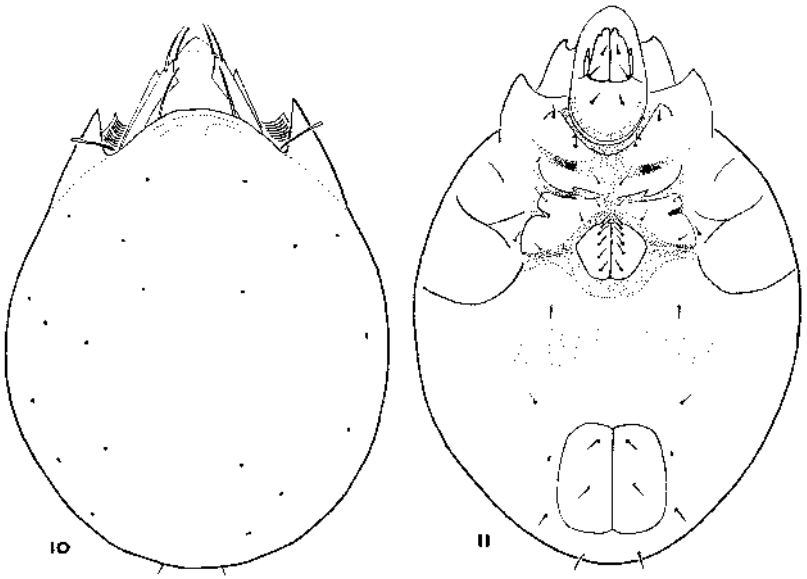
Genital covers with six pairs of setae in medial rows, anterior pair inserted on anterior border of covers; anterior border overlaps ventral plate so that cover is pressed inward, a chitinous triangle present at anterior border, perpendicularly directed inward. Apodema III a short chitinous bar ending approximately twice its length from genital aperture. Apodema IV bisecting the lateral angle of genital cover, with a conspicuous channel (Fig. 11). Anal covers tapered anteriorly; anal setae as figured (Fig. 11).

Length of female 1190μ, width 900μ.

Discussion: According to Sellnick (1952), this species was collected by "Prof. C. M. L. Baeta Neves, 26/8/1951, under the bark of a dead tree of Pinus Pinaster Sol. ex Ait. Average diameter of the stand 20 cm, height 12 m, age 30 years.

"Patria : Tapada do Mouco, near Parque da Pena, in the Mountains of Sintra, western of Lissabon, altitude ca. 400 m."

The writers did not examine specimens of this species.



Hafenrefferiella nevesi Sellnick, legs omitted: Figure 10, dorsal view ; Figure 11, ventral view (after Sellnick, 1952).

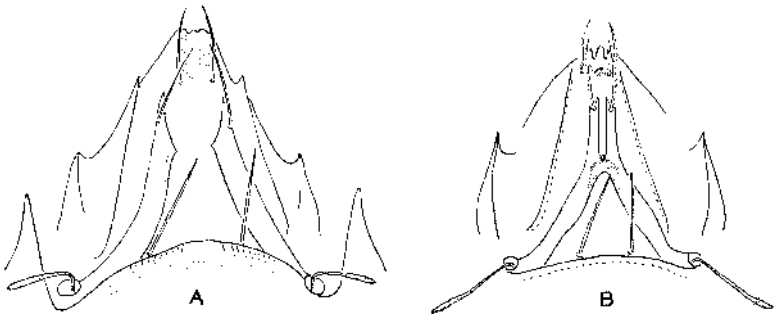


Figure 12. Dorsal view of the propodosoma of (A) *Hafenrefferiella nevesi* Sellnick, 1952 (after Sellnick, 1952) and (B) *Hafenrefferia gilvipes (C.* L. Koch, 1839) Oudemans 1906 (after Sellnick, 1952).

KEY TO GENERA AND SPECIES OF TENUIALIDAE

Pteromorphae extending beyond the anterior margin of hysterosoma as rigid plates, pointed and free at their anterior ends
Family Tenuialidae Jacot, 1929.

1. Lamellae narrow, not extending beyond anterior end of gnathosoma, with or without a translamella ; pteromorphs short 3

   Lamellae broad and long, extending beyond the anterior end of gnathosoma ; with or without a translamella ; pteromorphs long Genus *Tenuiala* 2

2. Lamellae broad, unnotched laterally and joined by a trans-lamella *nuda* Ewing, 1913.

   Lamellae broad, notched laterally and joined at their anteromedial margins without a translamella *kurti* sp. nov.

3. With a translamella ; pteromorphae heavily sclerotized along entire medial margin
   Hafenrefferia gilvipes (C. L. Koch) Oud., 1906.

   Without a translamella ; pteromorphae slightly sclerotized along proximal half of medial margin
   Hafenrefferiella nevesi Sellnick, 1952.

Summary: The pteromorphae, lamellae and genital setae are features of *Tenuiala, Hafenrefferia* and *Hafenrefferiella* which constitute, in the writers' opinions, the basis for the inclusion of these genera in a separate family. Comparisons of these structures in *Tenuiala nuda* and *T. kurti, Hafenrefferia gilvipes* and *Hafenrefferiella nevesi* seem to demonstrate a rather logical sequence of development from an unspecialized arrangement to a specialized condition.

This developmental pattern is the least noticeable in the genital setae, less pronounced in the pteromorphae and the most obvious in the lamellae. While the genital setae show little variation and the pteromorphae a minor amount in these genera, the writers suggest that even the slight modifications in the pteromorphae are indicative of a transition and specialization.

Tenuiala kurti exhibits a medial fusion of broad lamellae, which is considered by the writers to be the least specialized. The lamellae of

T. nuda are connected by a distinct translamella. It seems logical to assume, therefore, that *T. kurti* is more primitive with respect to this character and that the translamella of *T. nuda* constitutes an advanced condition. The pteromorphal developments are less pronounced in both of these species than in the species of the other two genera.

Hafenrefferia shows a marked reduction in the length and general size of the lamellae and the translamella, with modifications of the cusps into long projections and insertion points for the lamellar hairs. These cusps are elevated according to the descriptions of Sellnick (1952). The pteromorphae are reduced in size, but heavily sclerotized along the entire medial margins.

The most specialized of the genera is *Hafenrefferiella* in which the lamellae are widely separated, with pronounced cusps and without a translamella. The pteromorphae similate those of *Hafenrefferia,* but differ in the sclerotization of the proximal part of the medial margins.

While the writers admit minor variations among individuals, as evidenced for *T. kurti* (Fig. 6), these three genera seem to demonstrate changes in structural features that show a gradual transition within the family. Each genus is distinct, but the existing basic similarities in the pteromorphae, lamellae and genital setae seem conclusive evidences for the separation of the family Tenuialidae, as well as proof of the transitional structural pattern. The only qualification which should he made is that specimens of *Hafenrefferia* and *Hafenrefferiella* were unobtainable and were not examined. The excellent details of Sellnick's drawings, however, seem conclusive and corroborative.

Acknowledgements. Sincere thanks are here expressed for the pencil drawings of *Tenuiala nuda* Ewing provided by Dr. E. W. Baker. Grateful appreciation is also given to Dr. Max Sellnick for the loan of his paper on *Hafenrefferiella* and for his permission to modify his descriptions and to use his figures.

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